National Transportation Safety Board

Washington, D. C. 20594

Safety Recommendation Log 2114

Date: January 9, 1988

In reply refer to : A-88-160 through -162

Honorable T. Allan McArtor
Administrator
Federal Aviation Administration
Washington, D.C. 20591

The National Transportation Safety Board has investigated two accidents that involved an in-flight loss of engine power. The first accident occurred in Oshtemo Township, Michigan, on October 23, 1987,[1] and involved a Ted Smith Aerostar 600 (Piper PA-60) airplane that had a total loss of power in the right engine while cruising at 9,000 feet msl. As a result of the crash and postcrash fire, the pilot, who was the sole occupant, was fatally injured, and the airplane was destroyed. The second accident occurred near Mansfield, Ohio, on December 3, 1987,[2] and involved a Piper PA 60-600 airplane that had a total loss of power in the right engine in instrument flight rules and icing conditions. During the crash, the pilot, who was the sole occupant, sustained serious injuries, and the airplane was destroyed.

The investigation revealed that, for both accidents, the in-flight loss of engine power was precipitated by the separation of a cylinder from the engine case. The investigation also revealed that both airplanes used Lycoming IO-540-K1 engines and that both of the engines that lost power had been repaired by the same company. The engine involved in the Oshtemo Township accident had been weld-repaired 321 hours before the accident. The engine involved in the Mansfield accident had been weld-repaired about 300 hours before the accident.

The engine case halves, through bolts, and cylinder hold-down studs from the engines, were the subject of a metallurgical examination at the Safety Board's Materials Laboratory. This examination revealed extensive fatigue cracking in the hold-down studs associated with the separated cylinders and to a lesser extent, in the two through bolts associated with the separated cylinders. The fatigue cracking associated with the cylinders on both engines appeared to initiate at or near the hold-down stud at the 10 o'clock position on the cylinder deck. Metallographic sections through the stud hole at the 10 o'clock position revealed that extensive weld-repair had been performed through the entire thickness of the case at this location. Hardness measurements on the section cut from the engine case from the Mansfield accident showed that the welded areas were much softer than the areas

[1]For more detailed information, read Field Accident Report No. CHI 88-F-A010 (attached).
[2]For more detailed information, read Field Accident Report No. ATL 88-F-A052 (attached).

that had not been welded. Fire damage on the engine case from the Oshtemo Township accident had melted portions of the case and had softened all the remaining portions of the case.

Fatigue cracking in a hold-down stud can initiate when the torque on the stud is less than the required amount. The Safety Board believes that current Federal Aviation Administration (FAA)-approved procedures allow softer, welded material to be introduced around the hold-down stud holes and that the presence of this softer material can cause partial release of the torque on the hold-down stud and can result in precipitation of fatigue cracking in the stud from that hole. Fatigue cracking in one stud can lead to fatigue cracking in additional studs and in the through bolts, and it can eventually result in separation of the cylinder from the case, loss of engine power, destructive damage to the airplane, and serious or fatal personal injuries as demonstrated by the accidents in Oshtemo Township and Mansfield. The Safety Board is also concerned that engine case weld repairs, when performed according to FAA-approved procedures, do not take into account the possible large number and sometimes critical locations of these welds.

Therefore, the National Transportation Safety Board recommends that the Federal Aviation Administration:

> Prohibit engine case weld repairs around the cylinder hold-down stud holes and through bolt holes and in other critically stressed areas, unless the welded areas can be rehardened without excessive warpage of the case. (Class II, Priority Action) (A-88-160)
>
> Amend engine case weld-repair procedures to provide guidelines for the maximum number of welds or amount of welding that can be allowed in noncritical areas. (Class II, Priority Action) (A-88-161)
>
> Issue a General Aviation Airworthiness Alert (Advisory Circular 43-16) informing owners, operators, and maintenance personnel of the potential problems associated with weld-repair of small engine cases and urge them to have repeated inspections of cylinder hold-down studs and engine through bolts for proper torque on engine cases that have been weld-repaired in critical areas. (Class II, Priority Action) (A-88-162)

KOLSTAD, Acting Chairman, and BURNETT, LAUBER, NALL, and DICKINSON, Members, concurred in these recommendations.

By: James L. Kolstad
Acting Chairman

National Transportation Safety Board
Washington, D.C. 20594

Brief of Accident

File No. - 2155 12/03/87 MANSFIELD,OH A/C Reg. No. N5001S Time (Lcl) - 2159 EST

---Basic Information---

Type Operating Certificate-ON-DEMAND AIR TAXI
Name of Carrier -AIR CONTINENTAL, INC.
Type of Operation -NON SCHED,DOMESTIC,CARGO
Flight Conducted Under -14 CFR 135
Accident Occurred During -APPROACH

Aircraft Damage
DESTROYED
Fire
NONE

Injuries	Fatal	Serious	Minor	None
Crew	0	1	0	0
Pass	0	0	0	0

---Aircraft Information---

Make/Model - PIPER PA-60-600
Landing Gear - TRICYCLE-RETRACTABLE
Max Gross Wt - 5500
No. of Seats - 2
Eng Make/Model - LYCOMING IO-540-K1J5
Number Engines - 2
Engine Type - RECIP-FUEL INJECTED
Rated Power - 290 HP
ELT Installed/Activated - YES/YES
Stall Warning System - YES

---Environment/Operations Information---

Weather Data
Wx Briefing - FSS
Method - TELEPHONE
Completeness - FULL
Basic Weather - IMC
Wind Dir/Speed- 310/004 KTS
Visibility - .250 SM
Lowest Sky/Clouds - UNK/NR
Lowest Ceiling - OBSCURED
Obstructions to Vision- FOG
Precipitation - NONE
Condition of Light - NIGHT(DARK)

Itinerary
Last Departure Point
CINCINNATI,OH
Destination
CLEVELAND,OH

ATC/Airspace
Type of Flight Plan - IFR
Type of Clearance - IFR
Type Apch/Lndg - ASR

Airport Proximity
OFF AIRPORT/STRIP

Airport Data
MANSFIELD LAHM MUNICIPAL
Runway Ident - 23
Runway Lth/Wid - 6795/ 150
Runway Surface - ASPHALT
Runway Status - DRY

---Personnel Information---

Pilot-In-Command
Certificate(s)/Rating(s)
COMMERCIAL
SE LAND,ME LAND

Age - 49
Biennial Flight Review
Current - YES
Months Since - 4
Aircraft Type - PA-60

Medical Certificate - VALID MEDICAL-NO WAIVERS/LIMIT

Flight Time (Hours)			
Total	6870	Last 24 Hrs	7
Make/Model	1170	Last 30 Days	UNK/NR
Instrument	640	Last 90 Days	337
Multi-Eng	2020		

Instrument Rating(s) - AIRPLANE

---Narrative---

THE PILOT DEPARTED LOUISVILLE, KY REPORTEDLY WITH A KNOWN OIL LEAK IN THE RIGHT ENGINE AND WAS ON THE SECOND LEG OF AN ON-DEMAND AIR TAXI CARGO FLIGHT. ABOUT 14 MINUTES AFTER ENTERING MANSFIELD APPROACH CONTROL AIRSPACE, THE PILOT REQUESTED AND RECEIVED AN ALTITUDE CHANGE FROM 5,000 TO 3,000 FT BECAUSE HE "WAS PICKING UP A LOT OF ICE." AFTER ENTERING CLEVELAND APPROACH AIRSPACE HE REPORTED THE RIGHT ENGINE HAD FAILED AND REQUESTED TO RETURN TO MANSFIELD. THE PILOT WAS INFORMED OF MANSFIELD WEATHER. HE THEN INDICATED HE WANTED TO TRY CLEVELAND, THEN REPORTED HE COULD NOT MAINTAIN ALTITUDE AND WANTED TO GO TO MANSFIELD. THE PILOT WAS RECEIVING VECTORS FROM MANSFIELD FOR AN ASR APPROACH TO RUNWAY 23 AND AT ABOUT 1 1/2 MILES FROM THE THRESHOLD THE PILOT REPORTED HE WAS LOWERING THE LANDING GEAR. THE AIRCRAFT THEN DISAPPEARED FROM THE RADAR SCOPE. INVESTIGATION REVEALED IMPROPER WELD REPAIRS TO THE RIGHT ENGINE CASE AND SEPARATION OF THE NUMBER SIX CYLINDER FROM THE CASE DUE TO FATIGUE CRACKING IN THE THROUGH BOLTS AND STUDS.

File No. - 2155 12/03/87 MANSFIELD,OH A/C Reg. No. N100TS Time (Lcl) - 2159 EST

Occurrence #1 LOSS OF ENGINE POWER(TOTAL) MECH FAILURE/MALF
Phase of Operation CRUISE - NORMAL

Finding(s)
1. 1 ENGINE FAILURE,TOTAL
2. ENGINE ASSEMBLY,CRANKCASE CRACKED
3. MAINTENANCE,MAJOR REPAIR IMPROPER - OTHER MAINTENANCE PSNL
4. ENGINE ASSEMBLY,OTHER - FATIGUE
5. ENGINE ASSEMBLY,CYLINDER - SEPARATION
6. OPERATION WITH KNOWN DEFICIENCIES IN EQUIPMENT - CONTINUED - PILOT IN COMMAND
7. COMPANY-INDUCED PRESSURE - PILOT IN COMMAND

Occurrence #2 IN FLIGHT COLLISION WITH OBJECT
Phase of Operation APPROACH - FAF/OUTER MARKER TO THRESHOLD (IFR)

Finding(s)
8. OBJECT - TREE(S)
9. WEATHER CONDITION - ICING CONDITIONS
10. WEATHER CONDITION - BELOW APPROACH MINIMUMS
11. LIGHT CONDITION - DARK NIGHT
12. IN-FLIGHT PLANNING/DECISION - DELAYED - PILOT IN COMMAND

Occurrence #3 IN FLIGHT COLLISION WITH TERRAIN/WATER
Phase of Operation DESCENT - UNCONTROLLED

---Probable Cause---

The National Transportation Safety Board determines that the Probable Cause(s) of this accident is/are finding(s) 3,4,5,12

Factor(s) relating to this accident is/are finding(s) 6,7,8,9,10,11

National Transportation Safety Board
Washington, D.C. 20594

Brief of Accident

File No. 2444 10/23/87 OSHTEMO TOWNSHIP,MI A/C Reg. No. N554AC Time (LST) - 0332 EST

--Basic Information

Type Operating Certificate	-AIR CARRIER ALL CARGO	Aircraft Damage			Injuries	
Name of Carrier	-AIR CONTINENTAL INC.	DESTROYED		Fatal	Serious	Minor	None
Type of Operation	SCHEDULED,DOMESTIC,CARGO	Fire	Crew	1	0	0	0
Flight Conducted Under	-14 CFR 135	ON GROUND	Pax	0	0	0	0
Accident Occurred During	LANDING						

Aircraft Information

Make/Model	- TED SMITH AEROSTAR 600	Eng Make/Model	LYCOMING IO 540-K1J5	ELT Installed/Activated - YES/NO
Landing Gear	TRICYCLE-RETRACTABLE	Number Engines	2	Stall Warning System - YES
Max Gross Wt	5500	Engine Type	- RECIP-FUEL INJECTED	
No. of Seats	- 2	Rated Power	- 290 HP	

---Environment/Operations Information---

Weather Data
- Wx Briefing - FSS
- Method - TELEPHONE
- Completeness - WEATHER NOT PERTINENT
- Basic Weather - VMC
- Wind Dir/Speed- 230/005 KTS
- Visibility - 10.0 SM
- Lowest Sky/Clouds - CLEAR
- Lowest Ceiling - NONE
- Obstructions to Vision- NONE
- Precipitation - NONE
- Condition of Light - NIGHT(BRIGHT)

Itinerary
- Last Departure Point: MILWAUKEE,WI
- Destination: CLEVELAND,OH

ATC/Airspace
- Type of Flight Plan - IFR
- Type of Clearance - IFR
- Type Apch/Lndg - STRAIGHT-IN
  FORCED LANDING

Airport Proximity
- OFF AIRPORT/STRIP

Airport Data
- KALAMAZOO
- Runway Ident - N/A
- Runway Lth/Wid - N/A
- Runway Surface - N/A
- Runway Status - N/A

----Personnel Information----

Pilot-In-Command
- Age - 47
- Certificate(s)/Rating(s): ATP,CFI; SE LAND,ME LAND; HELICOPTER
- Instrument Rating(s) - AIRPLANE
- Biennial Flight Review: Current - YES; Months Since - 2; Aircraft Type - PA-60
- Medical Certificate - VALID MEDICAL-NO WAIVERS/LIMIT

Flight Time (Hours)

Total -	3290	Last 24 Hrs -	UNK/NR
Make/Model-	101	Last 30 Days-	26
Instrument-	352	Last 90 Days-	173
Multi-Eng -	868	Rotorcraft -	422

----Narrative----

THE AIRCRAFT WAS AT CRUISE ALTITUDE (9,000 FEET) FOR APPROXIMATELY 20 MINUTES WHEN THE PILOT REPORTED THE LOSS OF RIGHT ENGINE POWER. CHICAGO ARTCC REPORTED THE CLOSEST AIRPORT WAS KALAMAZOO, 28 MILES WEST. THE AIRCRAFT BEGAN TO DESCEND AND AT 0330:53 CHICAGO ARTCC REPORTED N554AC WAS APPROXIMATELY 6 MILES FROM KALAMAZOO AIRPORT. THE PILOT REPORTED "MY RIGHT ENGINE COWLING IS GONE...I DON'T KNOW IF I'M GOING TO MAKE IT." WITNESSES OBSERVED THE AIRCRAFT AT "TREE TOP LEVEL" AND IMPACT IN A HEAVILY WOODED AREA NEAR INTERSTATE 94, 5 MILES FROM THE AIRPORT. INVESTIGATION REVEALED IMPROPER WELD REPAIRS TO THE RIGHT ENGINE CASE AND SEPARATION OF THE NUMBER 2 CYLINDER FROM THE CASE DUE TO FATIGUE CRACKING IN THE THROUGH BOLTS AND STUDS. THE TOP SECTION OF THE ENGINE COWLING SEPARATED DUE TO THE FORCE OF THE CYLINDER SEPARATION.

File No. - 2444 10/23/87 OSHTEMO TOWNSHP,MI A/C Reg. No. N5546C Time (Lcl) - 0332 EDT

Occurrence #1 LOSS OF ENGINE POWER(TOTAL) - MECH FAILURE/MALF
Phase of Operation CRUISE - NORMAL

Finding(s)
1. 1 ENGINE - FAILURE,TOTAL
2. ENGINE ASSEMBLY,CRANKCASE - CRACKED
3. MAINTENANCE,MAJOR REPAIR - IMPROPER - OTHER MAINTENANCE PSNL
4. ENGINE ASSEMBLY,OTHER - FATIGUE
5. ENGINE ASSEMBLY,CYLINDER - SEPARATION
6. COOLING SYSTEM,COWLING - SEPARATION

Occurrence #2 FORCED LANDING
Phase of Operation DESCENT - EMERGENCY

Finding(s)
7. LIGHT CONDITION - BRIGHT NIGHT
8. UNSUITABLE TERRAIN - SELECTED - PILOT IN COMMAND

Occurrence #3 IN FLIGHT COLLISION WITH OBJECT
Phase of Operation DESCENT - UNCONTROLLED

Finding(s)
9. OBJECT - TREE(S)

----Probable Cause----

The National Transportation Safety Board determines that the Probable Cause(s) of this accident is/are finding(s) 3,4,5,6

Factor(s) relating to this accident is/are finding(s) 7,8,9